

BIM + the Structural Engineer

What is the business impact of BIM modeling?

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BIM is the acronym for Building Information Modeling. Many software programs are now BIM capable, which in simple terms mean that they use a common format that defines the parts of a structure/building as objects, which have an X-Y-Z geometry location, specific material, loads expected, and a host of other information. All of this information is shown in a ³D graphic presentation, with layers that pertain to different disciplines making up the final BIM model. There is a layer for each part of the structure: CAD design, structural analysis, detailing, HVAC, plumbing, electrical, interior finishes, and as many others as the property developer/owner decides he wants to have in his finished BIM. Other layers that BIM probably will provide: time and cost.

Radically new? Revolutionary? Not really. All of these layers exist now, but mostly they are paper drawings, schedules, or documents, and it takes a trained eye to see just how each of these relates to the information from another discipline or layer. All of the different layers are already developed with CAD or other software, but BIM is more than just stacking up the different software files in a total model. The BIM allows you to see through the layers and view them in combinations. Just think: maybe the electrical contractor will stop punching holes in the shear wall and the HVAC guy make less grand elbows around columns or beams. Actually, this is quite likely. The latest generations of BIM software will make clash detection inherent.

The revolutionary BIM promise is that any change to any layer of the BIM model, will be recognized by the other layers, and if possible other layers (or parts within the layer) will be updated automatically. This type of idea has been working pretty well in CAD design programs for years; change the length of a wall, and the software will likely change the list of materials, quantities, etc. For the most part, other layers will simply be 'notified' of a change. Making a room bigger in the design layer, won't automatically update the structural analysis layer. Thankfully, we are a long ways from 'engineer in a box' capability. The bigger room may require a whole new structural approach, and maybe the HVAC layer is going to be thinking about a bigger capacity cooling unit, not just a few more feet of ducting. Still, just the idea that each layer can see the changes graphically in the BIM model is going to be a big advantage.

Newer architectural design software programs do more than just make their CAD files 'BIM compatible'. These programs will provide the visualization and object data of the layers and could also provide some or perhaps the entire 'layer hosting solution'. It appears that both the BIM layer visualization of the design software program and the BIM hosting solution will allow for automatic updating and clash detection that is one of the most important value propositions of the BIM concept.

Most of the CAD programs that become a part of the overall structure, will simply be BIM compatible, meaning that they will be able to import a BIM file from another

layer and to export their finished BIM file back to the BIM host or to export it to another BIM layer. A BIM compatible program also provides visual and some object data for the BIM layer that they import. Very few of these programs will offer automatic updating between layers. This example is the likely scenario for 'buildings', as they generally have an architectural design basis, and many of the major architectural CAD programs offer some form of BIM layer hosting. The structural, HVAC, electric, piping, finishing and other layers will be hosted by way of the architectural CAD program.

If an engineer is the first design initiator, like in tanks, towers, bridges, etc., then his engineering CAD program might be required to host the BIM. Specialized engineering CAD programs for analysis and detailing are probably never going to offer their programs as BIM hosts. So, in these examples, it is likely that the engineer is going to need a general architectural or mechanical CAD design program, capable of BIM hosting, if he is required by the project owner to offer a complete BIM solution.

The main wrinkle in the whole BIM process at this point is this idea of hosting the BIM model. Sounds a lot like hosting a website, because it is. It is a good bet that very, very few architects or engineers or any other of the layer disciplines look like good candidates to host anything. Most architect and engineer offices will be horrified to think that outside companies will have access to their computer network to make updates to the BIM model. Very few offices have an IT department equipped to be responsible for database management, uptime, backups, logins, firewalls, etc. The most likely solution that is emerging at this time will be 3rd party, Internet hosts of BIM models.

It seems likely that most BIM implementations will be configured where only one party has full access to the BIM hosted model and the various providers of the BIM layers will only have to be responsible for their own layer.

Most CAD disciplines, and certainly most of the engineering CAD disciplines will only need to use software that is BIM compatible, and it looks like all of the major brands are making their software capable of importing and exporting a BIM file. Structural engineers are well familiar with file compatibility issues: DWG, DXF, SDNF, CIS/2 and others are common. The problem with these file types is just that no developer really wanted to share too much info...it might cut into future sales.

Hurrah for progress in this area. A truly international file format has evolved over the last several years (and it still is being expanded) known as IFC. Every year or so, software developers of specific discipline layers come up with the specification of details that their IFC file format layer must contain. This means that not all of the future potential of BIM modeling is actually available now from all the CAD program layers, simply because they don't have the specifications done for their layer. They will, count on it.

At this time, it appears that most CAD design software delivers an IFC file that is useable by a structural analysis program that can import the IFC format. However, the IFC format for export of the structural analysis to the detailing software is not yet complete. Until this specification is implemented in IFC for structural analysis, the

engineer will have to look for the same old special data interfaces (or even some 'enhanced' IFC) to connect analysis results to detailing design software.

Most of the ³D programs in use in structural engineering offices are now, or will soon be IFC file compatible, meaning that they can be used in the BIM model. However, there are a lot of questions on the table regarding software programs that produce results in only ²D or only tabular form. These types of results will likely get integrated into the BIM model only by reference, and then this could really get ugly. The BIM model simply can't deliver the promised value unless the layers are produced in ³D.

Now there is the main issue. 75% of structural engineers work only with ²D software. Their business is sometimes to design the structure, and generally always to analyze a structure, and often times to make the production drawings so the workers can build it.

Most structural engineering offices are not worried about this whole BIM issue, because they have heard that this is only going to be a part of the BIG money projects. Certainly, it is likely that projects are going to probably be in the \$50 million and up area to demand full BIM solutions. However, it seems that almost all structural engineering offices will likely have to have some software that is BIM compatible, meaning IFC import/export capable, because governments are looking (or already have implemented new rules, i.e., USA and Singapore) at requiring submissions of CAD work be BIM capable.

Apparently, governments are willing to have available a BIM model that shows only ²D views, if that is all they can get. The ²D engineering software user must keep in mind however, that BIM is more than a view; it is information about objects. So simple, old style ²D software that is not developed as an 'object oriented' definition, is simply not going to work in the BIM model. Okay, maybe some footnotes or links in the BIM layer to outside data files might keep some of this software alive for years, but don't count on it.

The structural engineer office is going to have to truly consider ³D software. No time to panic...³D software today can often be used in the traditional ²D mode, and when you're ready, you can see your work in ³D. Actually, the experience many engineers had in University some 10 years ago or more, regarding ³D software is just not valid. Back then, ³D software was a major headache, and just not worth the trouble to use. It is much, much easier to use now and it is only habit (okay maybe money for new software) that keeps ²D the predominant CAD method used by engineers now. Now before you say no to this persuasion, consider that Google (now that is a big deal) has just bought the fastest growing ³D software program in the world. (SketchUp). One might suppose it must be so easy to use that they are thinking millions of users? Well... it is easy to use.

One issue the structural engineer office will have to consider no matter what BIM compatible program that they use, it whether the IFC layer file offered to them is done correctly. If not, it is possible that it can take more time to fix the errors, than to just start with a basic DXF/DWG import, and do it right the first time. There are some new programs whose sole purpose is to 'check' BIM models for accuracy, but at some

point the architectural CAD program is going to have to include this feature. These IFC validity checking software programs may also be able to display the BIM layers, offer crash detection, and perhaps some will also become full BIM hosting solutions.

Some architectural industry gurus are suggesting that the architect get paid more money for the production of these BIM models, because he now gets to (has to) make definitions of the objects well beyond the traditional CAD deliverable. The engineer office may be contracted with some new language in the agreement about BIM/IFC files, and this would not be a good time to just assume all is well. I suspect we should make sure that we are only willing to accept IFC files, if they have some guarantee that the data (the INFORMATION part of BIM) is actually correct.

The idea that BIM is somehow going to reduce the cost of professional engineering services is ridiculous. Anyone who wants an engineer to lower his price offer based on receiving a BIM/IFC file, which contains all of the wonderful work produced by some other layer provider, should be prepared to guarantee that the engineer is simply not responsible for the results. Reminds me of the old computer acronym: GIGO (garbage in-garbage out).

Seems more likely that the promotion of the value proposition of the BIM concept should focus on the issues of design detection of layer clashes (heating ducts around beams or columns in front of windows), on the ultimate value to the owner of having a full 3D model for future management and not on some theoretical savings of design fees.

The likely impact on the structural office from the expansion of the BIM concept:

- 1- Engineers with 3D software now will have to get the IFC extension module from their current software provider (might be free, not going to be thousands for sure). This way they can at least import the CAD file from almost any major design software.
- 2- Engineers with 2D software might get by for a few years, if the software is object oriented based, and they will also have to obtain the IFC extension module.
- 3- Engineers using simple 2D or tabular (excel spreadsheets, etc) software are going to have to buy new software.
- 4- Engineers are unlikely to have to host a BIM model unless it is a really big deal and they are prepared to staff an IT department, but likely they will be able to 'rent' space on an Internet BIM host. Whether or not they must also buy 'BIM hosting software' remains a guess.
- 5- Engineers will have to learn how the various layer 'update changes' or 'clash detection' systems of the BIM host work, and also how to make sure that their BIM/IFC export file is correct as well.
- 6- Engineers need to stay on top of procedural changes of various government offices so they can continue working even on the smallest of projects.
- 7- Engineers will likely be able to approach the implementation of BIM in an incremental way. At the beginning, the BIM (IFC) value to the structural engineer will only be that the file format is truly universal and import/export between CAD design and structural analysis layers will be

available. Only when all of the structural layer IFC file definitions are complete for the steel design, rebar reinforcement design and schedule, production drawings, fabrication drawings, etc., will the engineer office be able to fully utilize the value of the BIM concept.

- 8- Engineers may have to 'educate' the CAD layer provider that producing an IFC file does not necessarily mean that there is going to be any time savings for the engineering work. Certainly, very little will change until all of the IFC definitions needed for structural engineering work are done.

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